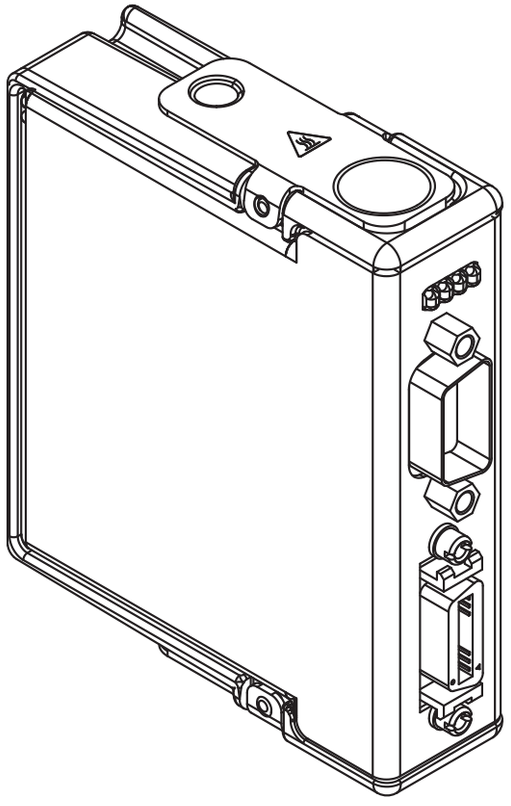
OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI 9512

Stepper Drive Interface Module with Encoder Feedback

Français Deutsch 日本語 한국어 简体中文

ni.com/manuals



NATIONAL INSTRUMENTS™

This document describes how to use the National Instruments 9512 module and includes specifications and pin assignments for the NI 9512. Visit `ni.com/info` and enter the Info Code `rdsoftwareversion` to determine which software you need for the modules you are using. For information about installing, configuring, and programming the system, refer to the system documentation. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Note The safety guidelines and specifications in this document are specific to the NI 9512. The other components in the system may not meet the same safety ratings and specifications. Refer to the documentation for each component in the system to determine the safety ratings and specifications for the entire system.

Tip NI offers the P7000 series AC and DC stepper drives and matched stepper motors. Refer to *Getting Started with NI 9512 C Series Drive Interface Modules and P7000 Series Stepper Drives* for installation and configuration information for P7000 stepper drives. NI also offers AKD analog servo drives and matched servo motors. These drives accept step and direction signals from the NI 9512 module. Refer to *Getting Started with NI 9512 C Series*

Drive Interface Modules and AKD Analog Servo Drives for installation and configuration information for AKD servo drives. Refer to the *Getting Started with NI 951x C Series Drive Interface Modules and LabVIEW* for information about using the NI 9512 with other devices.

Safety Guidelines

Operate the NI 9512 only as described in these operating instructions.

Hot Surface This icon denotes that the component may be hot. Touching this component may result in bodily injury.

Special Conditions for Marine Applications

Some modules are Lloyd's Register (LR) Type Approved for marine applications. To verify Lloyd's Register certification, go to `ni.com/certification` and search for the LR certificate, or look for the Lloyd's Register mark on the module.

Caution To meet radio frequency emission requirements for marine applications, use shielded cables and install the system in a metal enclosure. Suppression ferrites must be installed on power supply inputs near power entries to modules and controllers. Power supply and module cables must be separated on opposite sides of the enclosure and must enter and exit through opposing enclosure walls.

Connecting the NI 9512

The NI 9512 stepper drive interface module is part of a family of C Series motion modules. The module provides stepper drive interface signals for a single axis, a full set of motion I/O including inputs for a home switch and limit switches, incremental encoder inputs for position feedback, and 0 to 30 V digital input and output lines. The NI 9512 also includes a processor to run the spline interpolation engine and patented NI step generation algorithm. Working together they produce smoother motion resulting in precise stepper motion control.

System Connection

The NI 9512 has two connectors, a 15-pin DSUB drive interface connector and a 20-pin MDR feedback connector. The 15-pin DSUB includes command signals for interfacing with stepper drives, 0 to 30 V general-purpose digital input and output lines, and a +19 to 30 V input for power connection. Refer to Table 1 for the DSUB connector pin assignments.

The 20-pin MDR connector includes incremental encoder feedback inputs, a +5 V output for encoder power, home, limit, and position compare inputs, an output for position compare, an additional +19 to 30 V input for power connection, and an additional 0 to 30 V general-purpose digital input line. Refer to Figure 2 for the MDR connector pin assignments.

Note The NI 9512 requires an external power supply. You can connect the external power supply to the V_{sup} input provided on the DSUB or MDR connector. Do not connect more than one external power supply to the module.

National Instruments offers several options for connecting the NI 9512 to stepper drives. You can use the NI 9512-to-P7000 Stepper Drives Connectivity Bundle to connect the NI 9512 to the

P70530 or P70360 stepper drives from NI. You can also use the NI 9412 to AKD cable to connect to the AKD analog servo drive and AKM series servo motors from NI. To connect to third-party stepper drives, you can use the NI 951x Cable and Terminal Block Bundle. Refer to Figure 3 for the 37-pin terminal block pin assignments. Refer to the *NI 951x User Manual*, which you can download from `ni.com/manuals`, for information about additional connection accessories and cabling recommendations.

Note You can connect the NI 9512 to drives that support position command mode. Refer to the *NI 951x User Manual* for more information.

Complete the following steps to connect the NI 9512 stepper drive interface module to drives and other I/O:

1. Install the module in the chassis as specified in the chassis documentation.

Note Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for information about chassis, slot, or software restrictions.

2. Connect the module to a drive and other I/O using the NI 9512-to-P7000 Stepper Drives Connectivity Bundle, the NI 9512 to AKD cable, the NI 951x Cable and Terminal Block Bundle, or a custom cable for direct connectivity to third-party drives.
3. Connect the NI 9512 module to an external power supply.

Caution Do *not* connect anything to pins marked Reserved.

Caution The 37-pin terminal block has separate V_{sup} and COM terminals for each connector. Make sure you are using the correct V_{sup} and COM terminals for the connector you are using. All signals associated with the DSUB connector in Figure 3 are marked with a dagger (†).

Figure 1 shows a simplified system connection diagram.

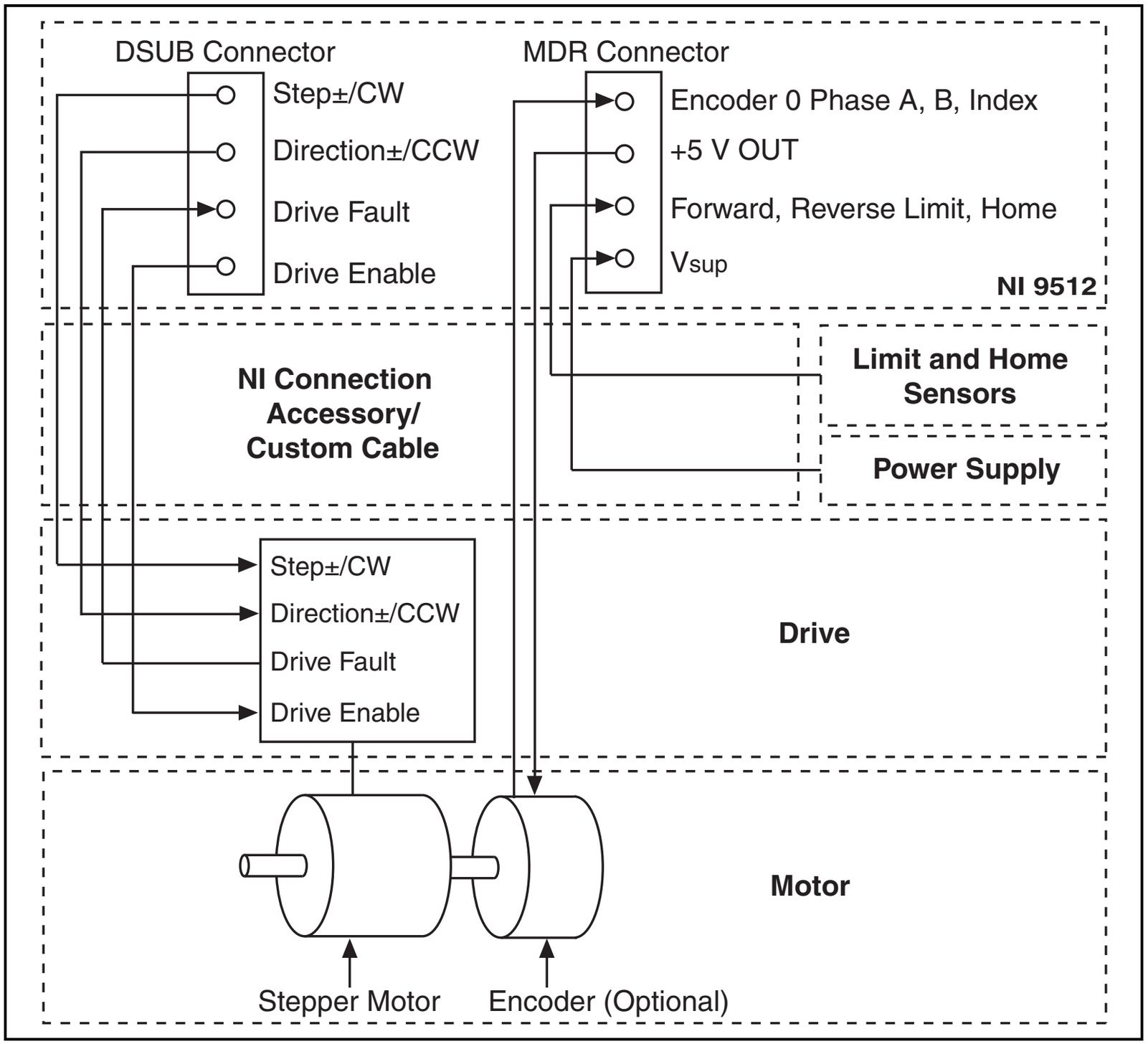
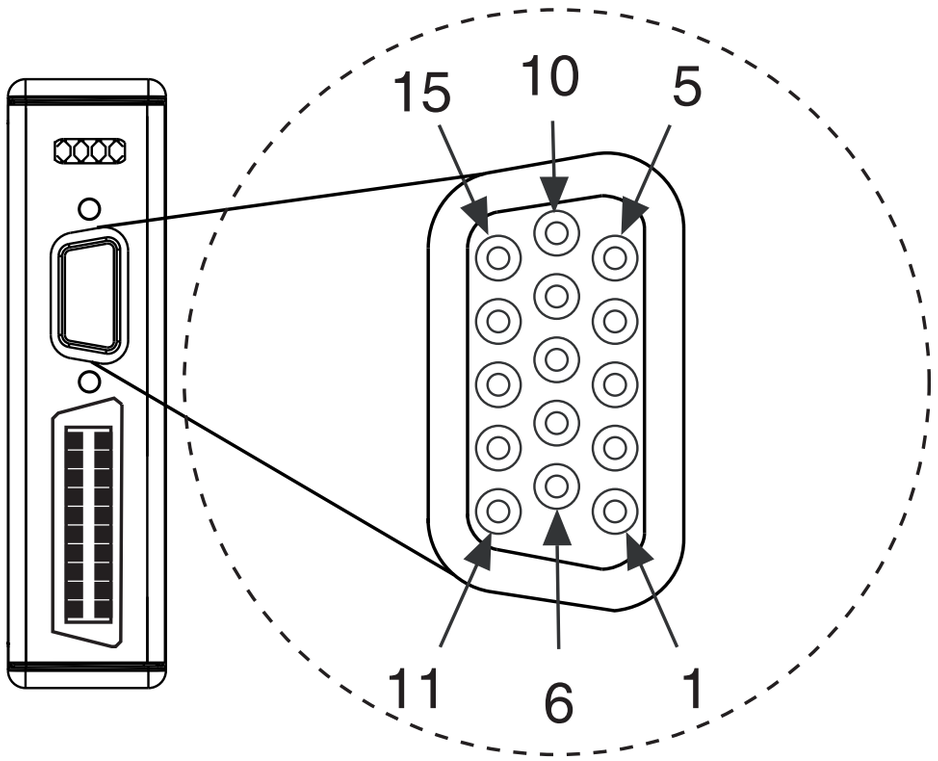


Figure 1. NI 9512 Connection Example

Table 1. NI 9512 DSUB Connector Pin Assignments

Connector	Pin	Signal
	1	Reserved
	2	Drive Enable
	3	Digital Input 3
	4	Digital Input 2
	5	Digital Output 1
	6	Reserved
	7	COM
	8	Digital Input 1
	9	Direction (CCW)–
	10	Step (CW)–
	11	Digital Output 0
	12	V_{sup}
	13	Direction (CCW)+
	14	COM
	15	Step (CW)+

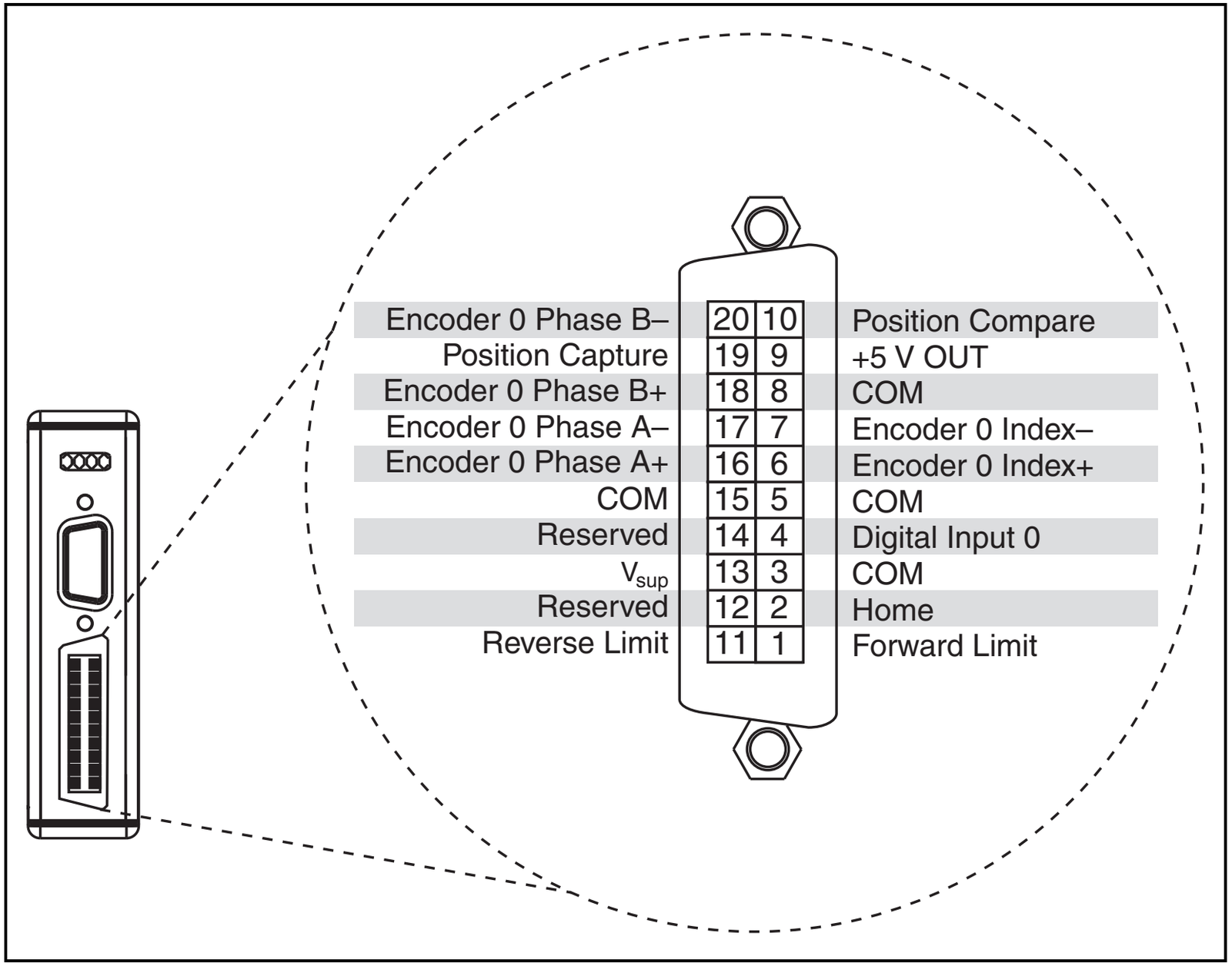


Figure 2. NI 9512 MDR Connector Pin Assignments

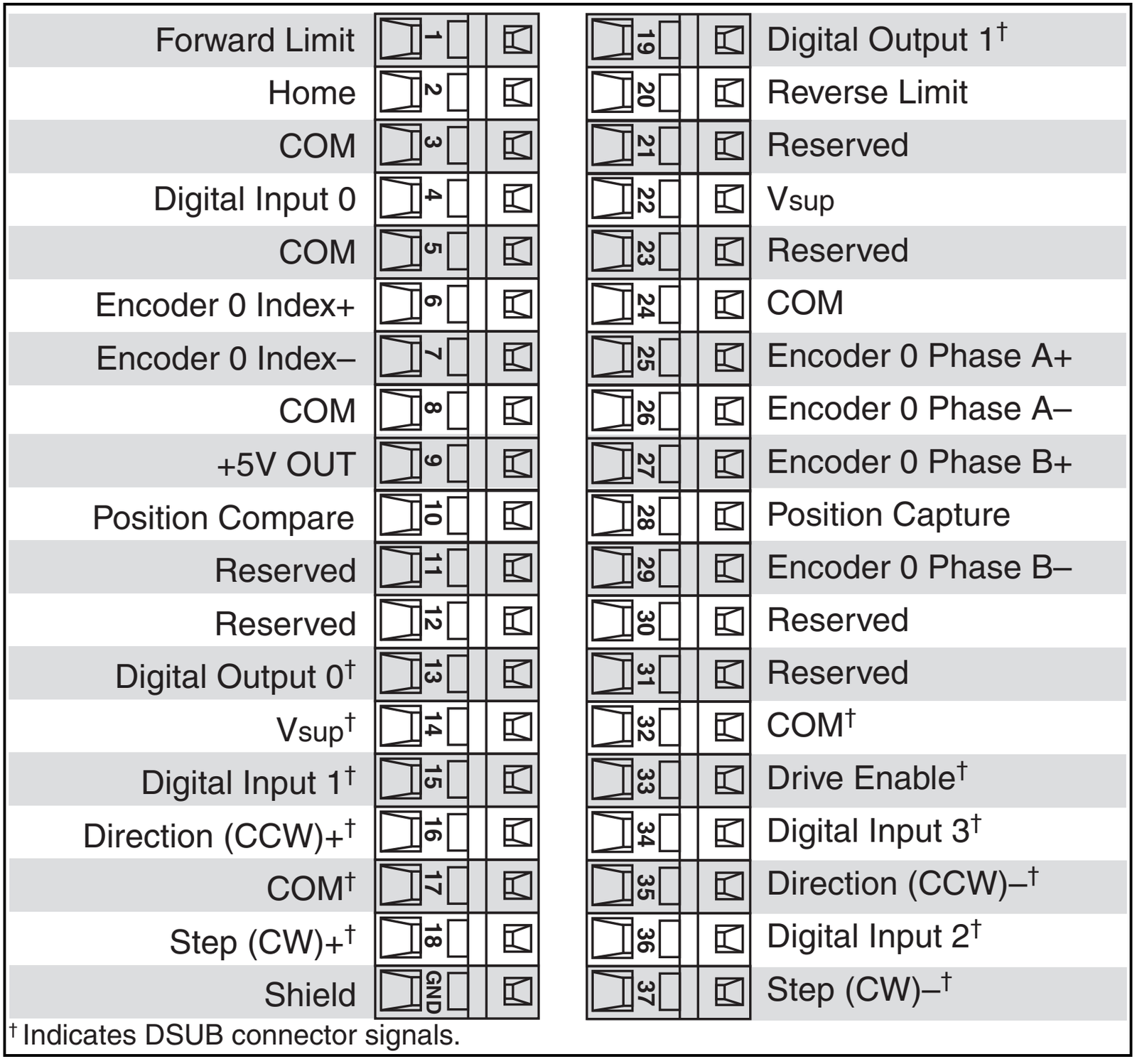


Figure 3. NI 9512 37-Pin Terminal Block Pin Assignments

Signal Connections

Figure 4 shows the NI 9512 block diagram.

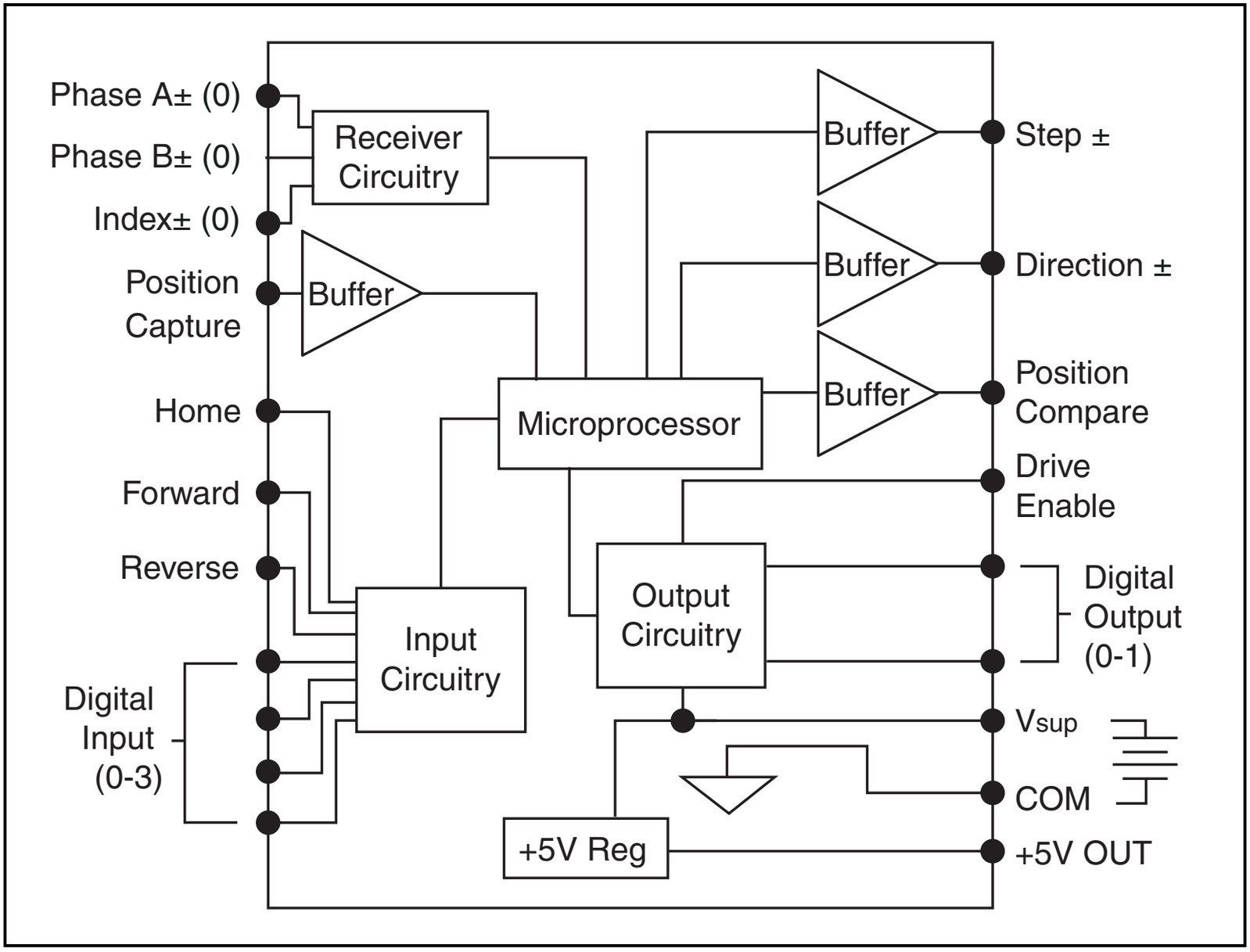


Figure 4. NI 9512 Block Diagram

Note This document provides a brief overview of the module signal connections. Refer to the *NI 951x User Manual*, which you can download from `ni.com/manuals`, for more information about signal connections.

The NI 9512 module supports both industry standards for stepper command signals—step and direction, or clockwise (CW) and counterclockwise (CCW) pulse outputs. The step and direction output circuits are software configurable for either single-ended or differential output type.

When connecting to drives with differential receiver inputs, configure the output type in software to differential and connect as shown in Figure 5.

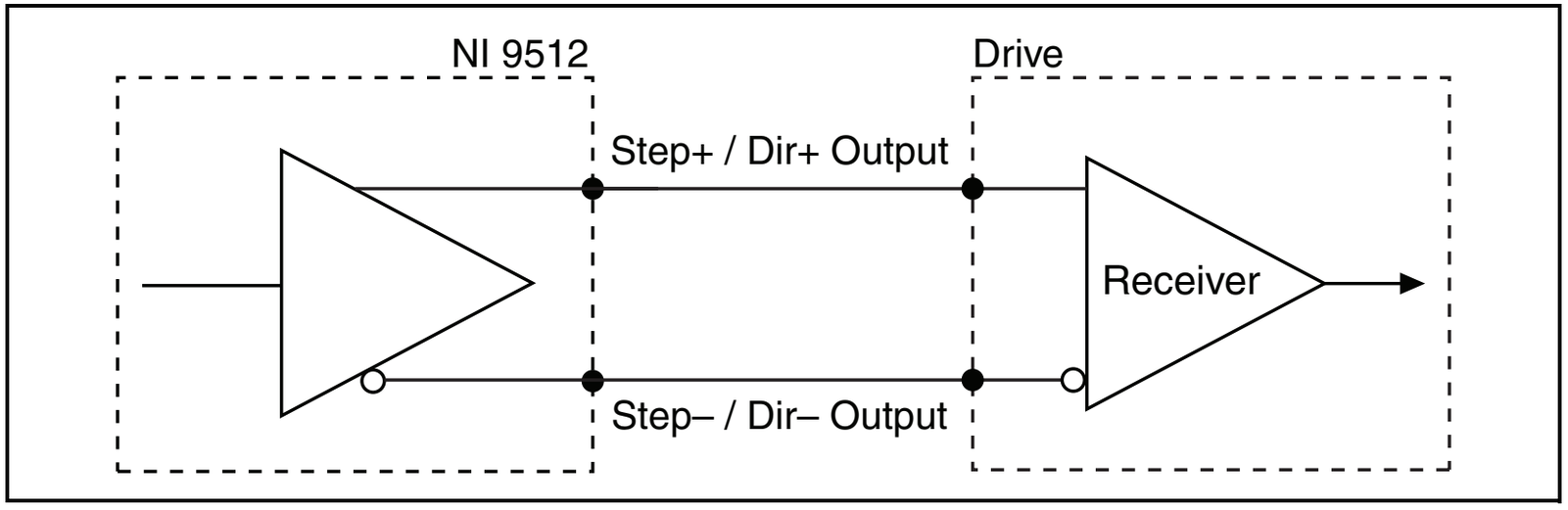


Figure 5. Differential Step and Direction Output Connection

Many stepper drive manufacturers offer opto-isolated inputs for Step (CW)/Direction (CCW) signals. When connecting to opto-isolated inputs, configure the Step output type to single-ended, connect the NI 9512 Step+ output to the negative (cathode) side of the optocoupler input, and leave the Step– output on the NI 9512 disconnected. Connect the positive (anode) side of the drive input to a supply as specified by the drive manufacturer. Figure 6 shows a single-ended connection example.

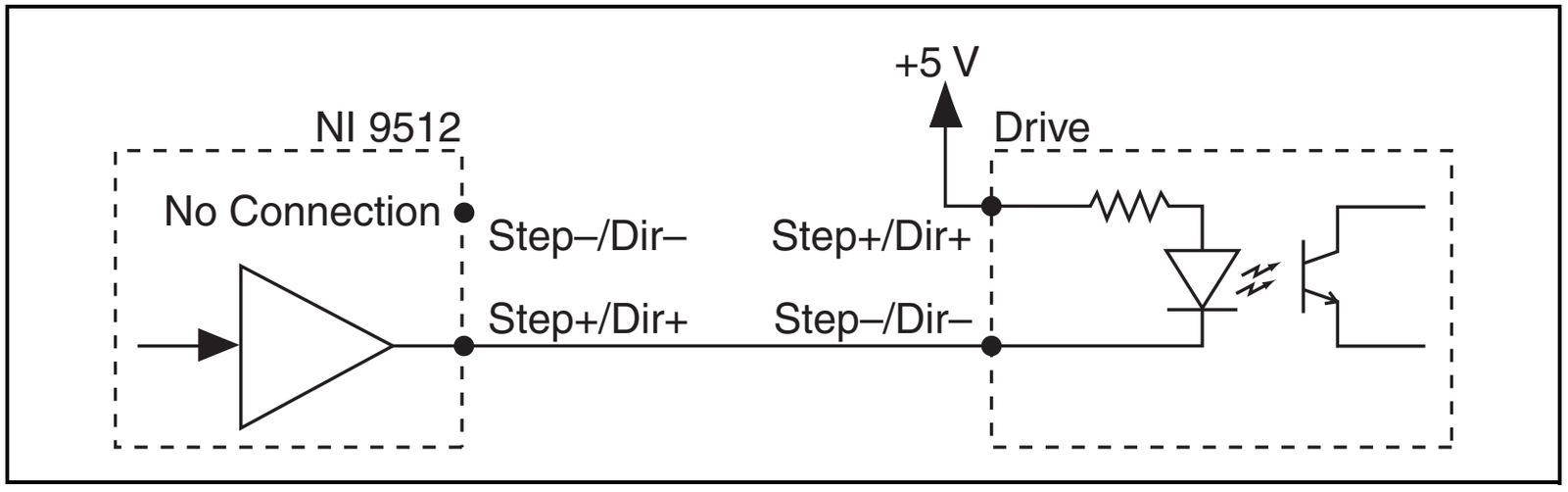


Figure 6. Opto-Isolated Step and Direction Output Connection

The encoder channel consists of a Phase A, a Phase B, and an Index input. The NI 9512 supports RS-422 differential and single-ended inputs for Phase A, Phase B, and Index signals, and provides a +5 V output for encoder power. National Instruments strongly recommends you use encoders with differential line driver outputs for optimized noise immunity and improved accuracy in all

applications. Figures 7 and 8 show simplified schematic diagrams of the encoder input circuit connected to differential and single-ended encoder outputs.

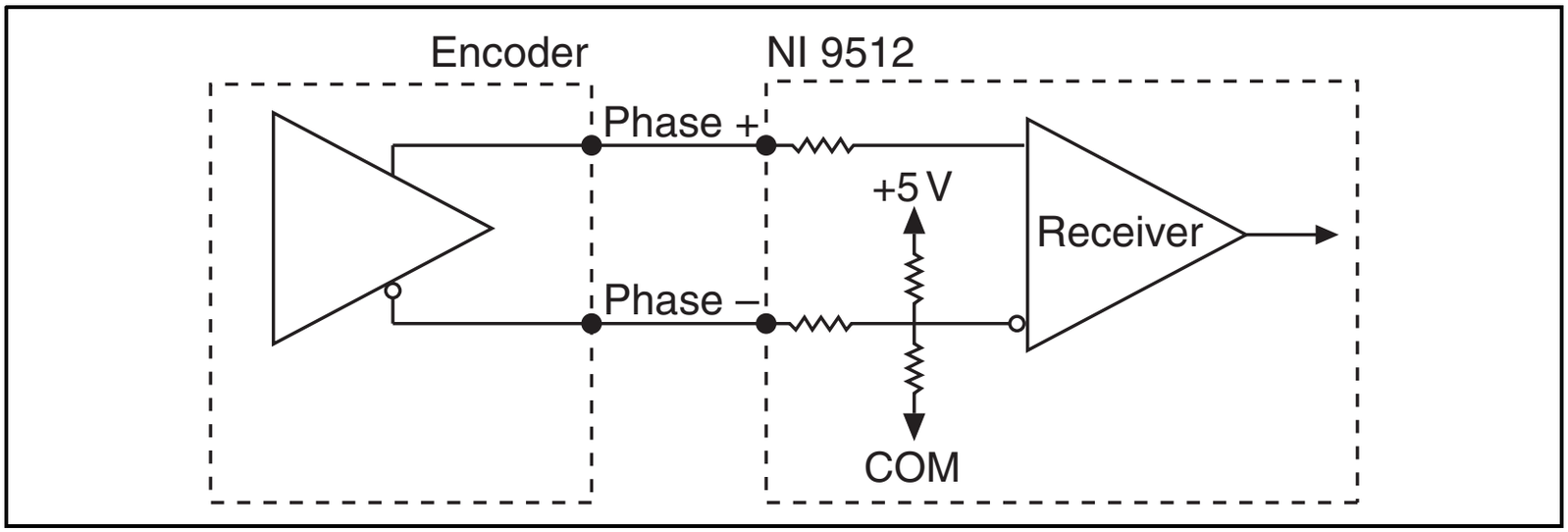


Figure 7. Differential Encoder Input Circuit

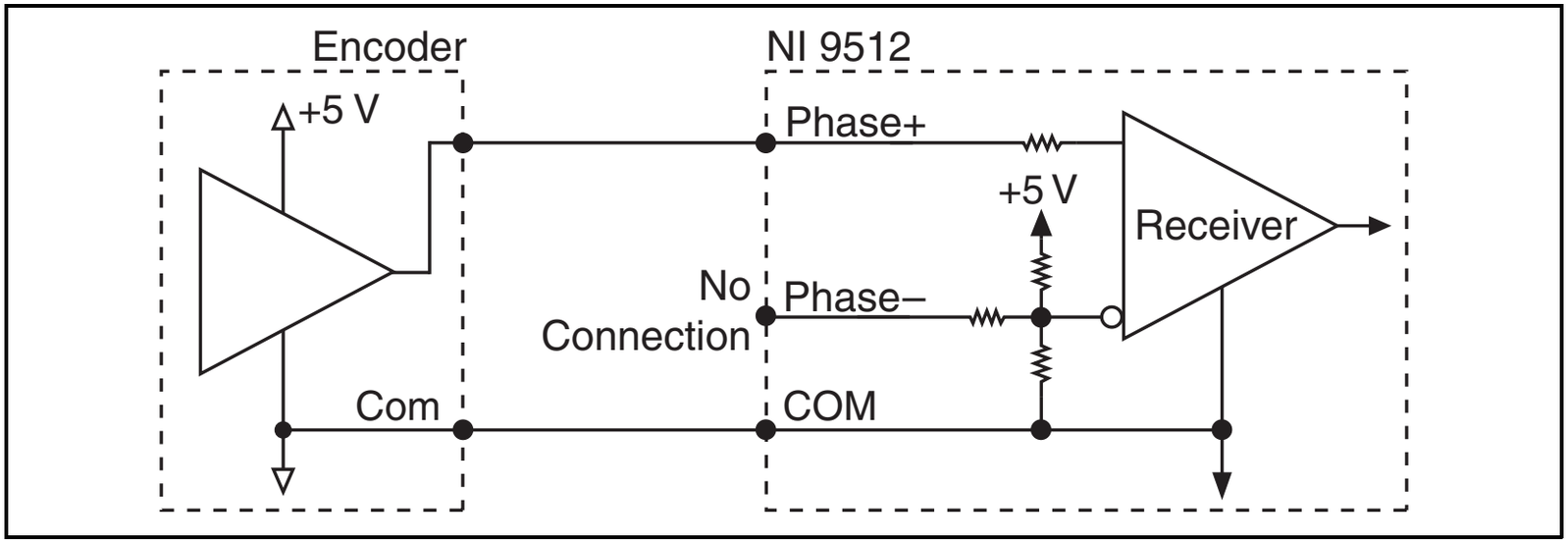


Figure 8. Single-Ended Encoder Input Circuit

You can configure the Forward Limit, Reverse Limit, Home, and Digital Input <1..4> circuits in software for current sinking or sourcing output devices and set the active state of the inputs in software to on or off. To use the Drive Fault functionality referenced in Figure 1, you can map an available digital input in software. Figure 9 shows an example of wiring the inputs to a sourcing output device.

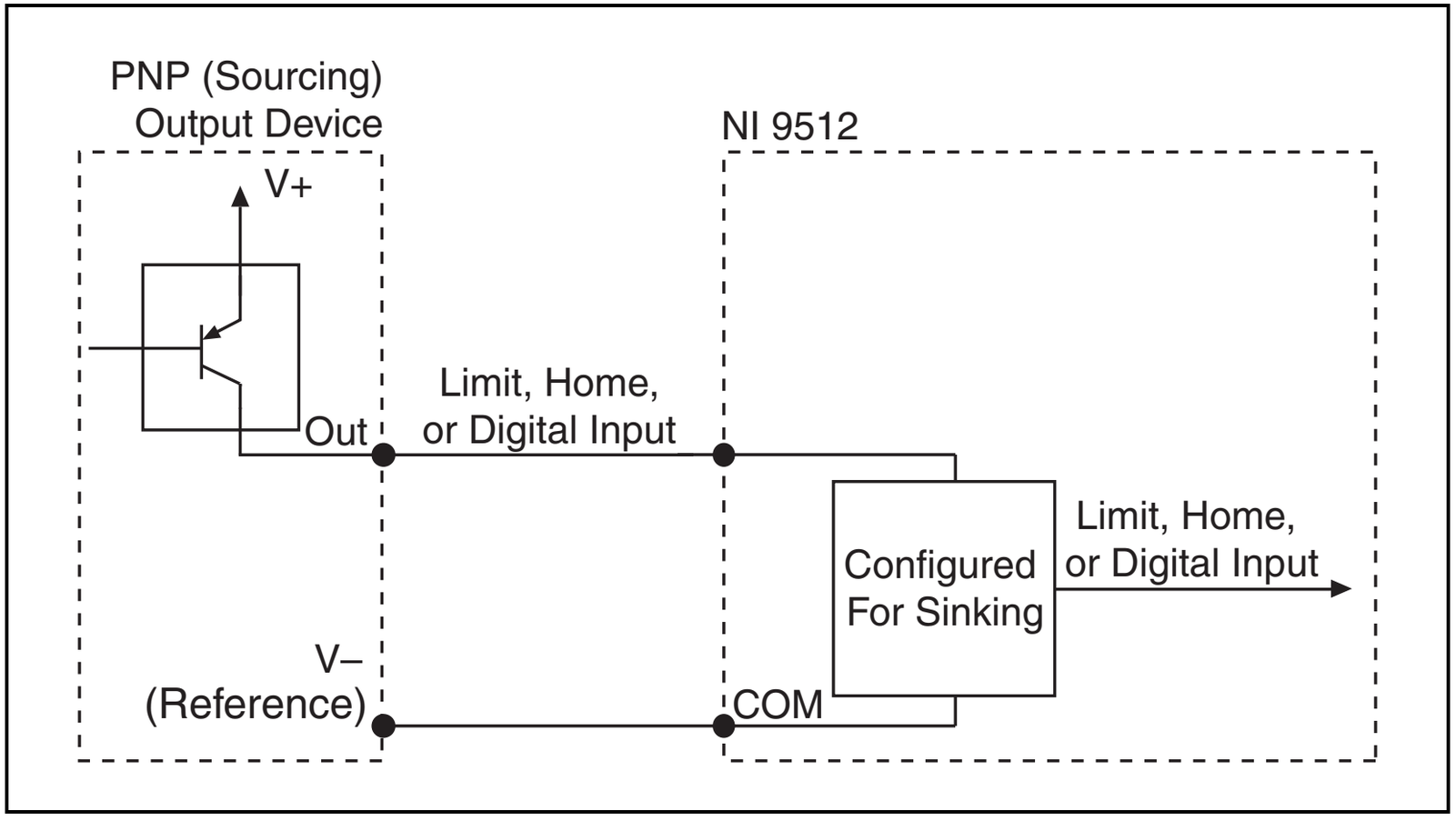


Figure 9. Limit or Digital Input Circuit Configured for Sinking

Figure 10 shows an example of wiring the inputs to a sinking output device.

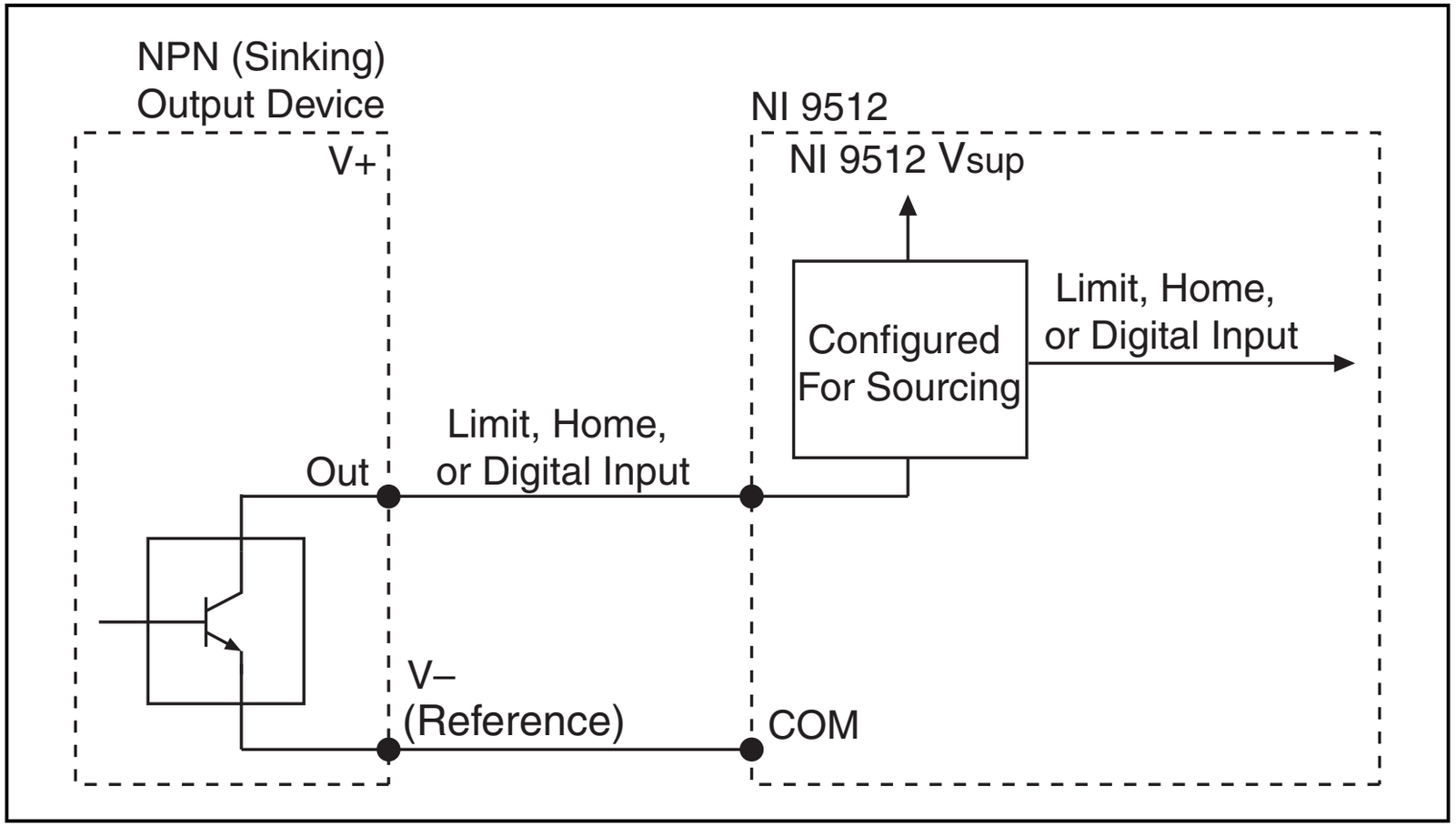


Figure 10. Limit or Digital Input Circuit Configured for Sourcing

The NI 9512 Drive Enable and Digital Output <1..2> circuits are software configurable for sinking or sourcing output type and the active state is software configurable for on or off.

Caution Do *not* connect digital outputs to +5 V input circuitry in either sinking or sourcing configuration.

Caution Only connect the Drive Enable output to +5 V input circuitry when the output is configured for sinking.

Figure 11 shows an example of wiring the outputs to a sinking input device.

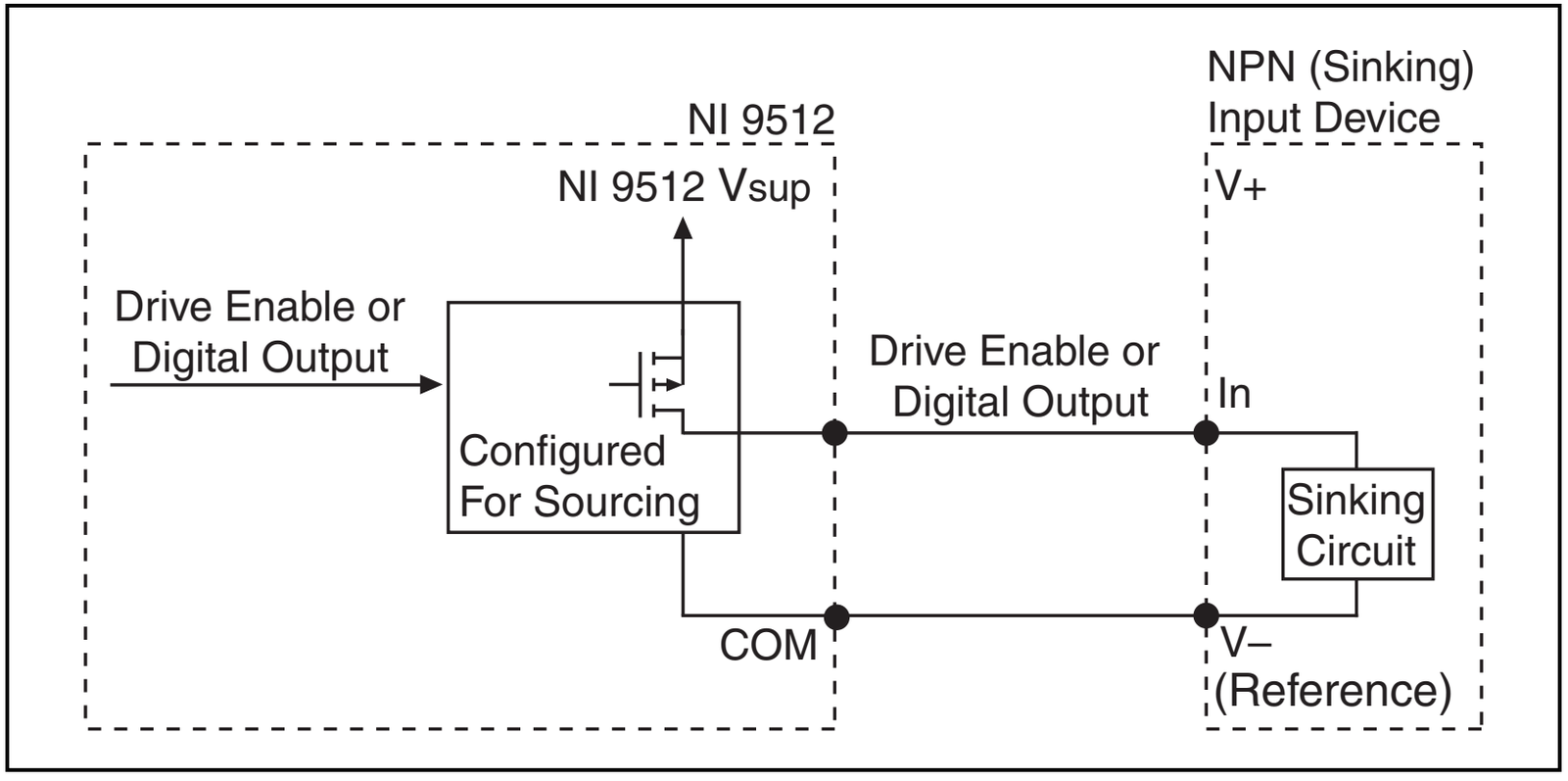


Figure 11. Drive Enable or Digital Output Circuit Configured for Sourcing

Figure 12 shows an example of wiring the outputs to a sourcing input device.

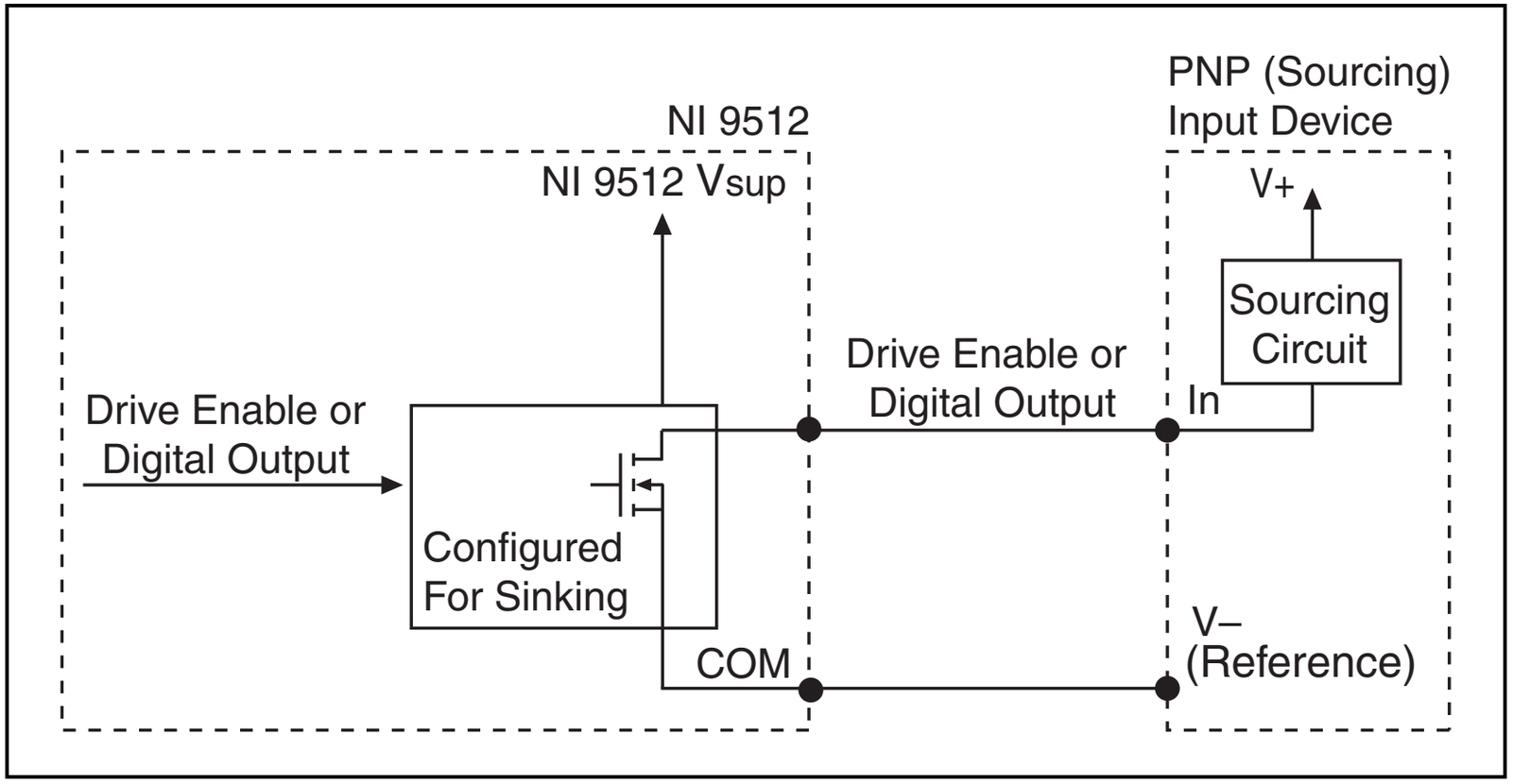
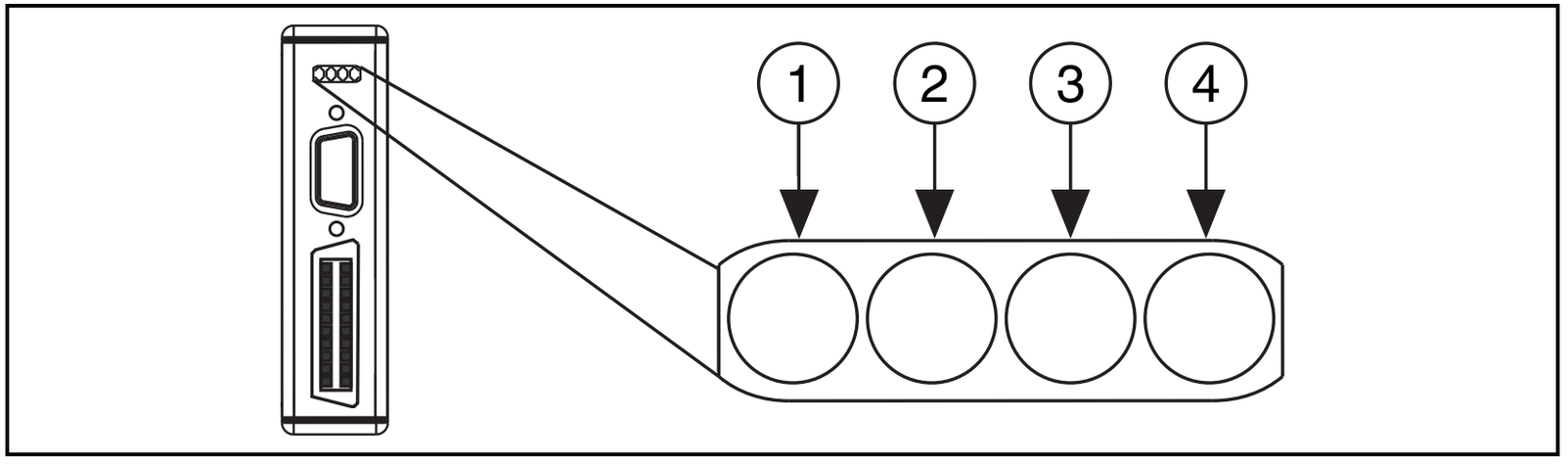


Figure 12. Drive Enable or Digital Output Circuit Configured for Sinking

LED Indicators

The NI 9512 has four LEDs to display status information.



1	Axis Status (Green)	3	Limit Active (Yellow)
2	Encoder Active (Green)	4	Axis Fault (Red)

Axis Status

The Axis Status LED (green) has three states to display axis status.

- **Off**—The module is in sleep mode or failed to boot correctly. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for troubleshooting information.
- **Flashing**—The module booted up correctly and is functional.
- **Lit**—The module is functional and the drive enable output is active.

Encoder Active

The Encoder Active LED (green) has three states for encoder and V_{sup} status.

- **Off—**The required power supply (V_{sup}) is not connected. You must connect a power supply to receive encoder pulses.
- **Flashing—**The power supply (V_{sup}) is connected and the module is receiving encoder pulses.

Note The LED flash rate does not correspond to the rate at which the NI 9512 receives encoder pulses.

- **Lit—**The power supply (V_{sup}) is connected but the module is not receiving encoder pulses.

Limit Active

The Limit Active LED (yellow) has two states to display the status of the limits and home input.

- **Off—**The power supply (V_{sup}) is not connected, or both the limits and home input are not active.
- **Lit—**The power supply (V_{sup}) is connected and the forward limit, reverse limit, or home input is active.

Axis Fault

The Axis Fault LED (red) has two states to indicate the presence of a fault in the system. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for a list of module faults and troubleshooting information.

- **Off**—No module faults.
- **Lit**—One or more module faults.

Sleep Mode

This module supports a low-power sleep mode. Support for sleep mode at the system level depends on the chassis that the module is plugged into. Refer to the chassis manual for information about support for sleep mode. If the chassis supports sleep mode, refer to the software help for information about enabling sleep mode. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Typically, when a system is in sleep mode, you cannot communicate with the modules. In sleep mode, the system consumes minimal power and may dissipate less heat than it does in normal mode. Refer to the *Specifications* section for more information about power consumption and thermal dissipation.

Specifications

The following specifications are typical for the range –40 to 70 °C unless otherwise noted. All voltages are relative to COM unless otherwise noted.

Stepper Performance

Stepper accuracy ..... 1 full, half, or microstep

Interpolation/spline rate ..... 20 kHz max

Motion Command Signals

Stepper outputs

- Output type ..... Programmable: single-ended or differential
- Digital logic levels, single-ended
- High, V_{OH} ..... 5.25 V max
  - Sourcing 20 mA ..... 3.5 V min
  - Sourcing 12 mA ..... 3.7 V min
  - Sourcing 4 mA ..... 3.9 V min
- Low, V_{OL}
  - Sinking 20 mA ..... 0.9 V max
  - Sinking 12 mA ..... 0.7 V max
  - Sinking 4 mA ..... 0.5 V max

Digital logic levels, differential (Step/Dir(+) – Step/Dir(–))

At 20 mA ..... ±1 V min

At 12 mA ..... ±1.5 V min

At 4 mA ..... ±2 V min

Max pulse rate ..... 5 MHz

Continuous output current on each channel ..... ±20 mA

Pulse width ..... Approximately 50% of the period, up to 6.4 µs max

Output mode ..... Programmable: step and direction, or CW/CCW

Active state ..... Programmable: high or low

Drive enable output

Output type ..... Programmable: sinking or sourcing

Voltage range ..... 0 to 30 V

V_{sup} input ..... 19 to 30 V

Continuous output current (I_0) on each channel ..... ±100 mA max

Output impedance (R_0) ..... 0.3 Ω max

Output voltage (V_0) sourcing..... $V_{sup} - (I_0 R_0)$

Output voltage (V_0) sinking..... $I_0 R_0$

Min output pulse width ..... 100 µs

Active state ..... Programmable: on or off

Motion I/O

Encoder 0 Phase A/B and Index inputs

Type ..... RS-422 differential or single-ended inputs

Digital logic levels, single-ended

Voltage ..... –0.25 to 5.25 V

High, V_{IH} ..... 2.0 V min

Low, V_{IL} ..... 0.8 V max

Digital logic levels, differential (Phase(+) – Phase(–))

Input high range ..... 300 mV to 5 V

Input low range ..... –300 mV to –5 V

Common-mode voltage[1] ..... –7 to 12 V

Input current at 5 V ..... ±1 mA

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[1] Common-mode voltage is the average of Phase+ and Phase–.

Min pulse width[1]

Differential ..... 100 ns

Single-ended ..... 400 ns

Max count rate

Differential ..... 20×10^6 counts/sec

Single-ended ..... 5×10^6 counts/sec

Forward, reverse, and home inputs

Input type..... Programmable: sinking or sourcing

Digital logic levels, OFF state

Input voltage ..... ≤5 V

Input current..... ≤250 µA

Digital logic levels, ON state

Input voltage ..... 11 to 30 V

Input current..... ≥2 mA

Input impedance ..... 30 kΩ ±5%

Min pulse width[1] ..... 100 µs

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[1] Assumes the minimum filter setting. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about filter options.

Position capture input

Digital logic levels

Voltage ..... –0.25 to 5.25 V

High, V_{IH} ..... 2.0 V min

Low, V_{IL} ..... 0.8 V max

Input current
(0 V ≤ V_{in} ≤ 4.5 V) ..... ±2 mA max

Min pulse width[1] ..... 100 ns

Max capture latency ..... 200 ns

Capture accuracy ..... ±1 count

Active edge ..... Programmable: rising edge or falling edge

Position compare outputs

High, V_{OH} ..... 5.25 V max

Sourcing 12 mA ..... 3.7 V min

Sourcing 4 mA ..... 3.9 V min

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[1] Assumes the minimum filter setting. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about filter options.

Low, V_{OL}

Sinking 12 mA ..... 0.7 V max

Sinking 4 mA ..... 0.5 V max

Compare mode ..... Programmable: single or periodic

Compare action ..... Programmable: set, toggle, or pulse

Max compare rate (periodic) ..... 5 MHz

Pulse width (programmable)

Min ..... 100 ns

Max ..... 1.6 ms

Active state ..... Programmable: high or low

Digital I/O

Inputs

Number of inputs 4

Input type ..... Programmable: sinking or sourcing

Digital logic levels, OFF state

Input voltage ..... ≤5 V

Input current..... ≤250 µA

Digital logic levels, ON state

Input voltage ..... 11 to 30 V

Input current..... ≥2 mA

Input impedance ..... 30 kΩ ±5%

Min pulse width[1] ..... 100 µs

Outputs

Number of outputs..... 2

Output type..... Programmable: sinking or sourcing

Voltage range..... 0 to 30 V

V_{sup} input..... 19 to 30 V

Continuous output current (I_0)
on each channel ..... ±100 mA max

Output impedance (R_0)..... 0.3 Ω max

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[1] Assumes the minimum filter setting. Refer to the *NI SoftMotion Module* book of the *LabVIEW Help* for more information about filter options.

Output voltage (V_0) sourcing..... $V_{sup} - (I_0 R_0)$

Output voltage (V_0) sinking..... $I_0 R_0$

Min output pulse width ..... 100 µs

Leakage current ..... 200 µA

Active state ..... Programmable: on or off

MTBF ..... Contact NI for Bellcore MTBF or MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis

Active mode ..... 925 mW max

Sleep mode ..... 0.4 mW max

Thermal dissipation (at 70 °C)

Active mode ..... 1.5 W max

Sleep mode ..... 0.4 mW max

V_{sup} input ..... 19 to 30 V, 375 mA max

+5 V regulated output ..... 5 V ±5%, 150 mA max

Physical Characteristics

If you need to clean the module, wipe it with a dry towel.

Note For two-dimensional drawings and three-dimensional models of the C Series module and connectors, visit `ni.com/dimensions` and search by module number.

Weight ..... 155 g (5.5 oz)

Safety

Safety Voltages

Connect only voltages that are within the following limits.

Channel-to-COM ..... 0 to +30 VDC max, Measurement Category I

Isolation

- Channel-to-channel ..... None
- Channel-to-earth ground
  - Continuous ..... 60 VDC, Measurement Category I
  - Withstand ..... 500 V_{rms}, verified by a 5 s dielectric withstand test

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as *MAINS* voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Caution Do not connect the NI 9512 to signals or use for measurements within Measurement Categories II, III, or IV.

Safety Standards

This product meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326-1 (IEC 61326-1): Class A emissions; Industrial immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Note For EMC compliance, operate this device with double-shielded cables.

CE Compliance CE

This product meets the essential requirements of applicable European Directives as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit `ni.com/certification`, search by module number or product line, and click the appropriate link in the Certification column.

Shock and Vibration

To meet these specifications, you must panel mount the system.

Operating vibration

Random (IEC 60068-2-64)..... 5 g_{rms}, 10 to 500 Hz

Sinusoidal (IEC 60068-2-6) ..... 5 g, 10 to 500 Hz

Operating shock (IEC 60068-2-27).... 30 g, 11 ms half sine,
50 g, 3 ms half sine,
18 shocks at 6 orientations

Environmental

National Instruments C Series modules are intended for indoor use only, but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature
(IEC 60068-2-1, IEC 60068-2-2) ..... –40 to 70 °C

Storage temperature
(IEC 60068-2-1, IEC 60068-2-2) ..... –40 to 85 °C

Ingress protection..... IP 40

Operating humidity
(IEC 60068-2-56) 10 to 90% RH, noncondensing

Storage humidity
(IEC 60068-2-56)..... 5 to 95% RH, noncondensing

Maximum altitude..... 2,000 m

Pollution Degree 2

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at `ni.com/environment`. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of the product life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers, National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, visit `ni.com/environment/weee`.

电子信息产品污染控制管理办法 （中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 ni.com/environment/rohs_china。 (For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at ni.com/support and follow the calling instructions or dial 512 795 8248. For

telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 662 457990-0,
Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599,
Canada 800 433 3488, China 86 21 5050 9800,
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 358 (0) 9 725 72511, France 01 57 66 24 24,
Germany 49 89 7413130, India 91 80 41190000,
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